

over the sunset becomes vividly brilliant, and at the same time delicately coloured. Over a somewhat depressed circular area, about 12° high and 15° broad, it assumes a pale green tint. Above this comes an equally dazzling pale yellow-orange, and again above this a soft rose colour melts away to the zenith. The revival of the light, or return from commencing twilight, is peculiarly striking. Buildings become brilliantly illuminated, and strong shadows are cast. All this outflow occurs in no more than five minutes, and now continues for about a quarter of an hour, but the brilliancy gradually contracts in area and sets with a magnificent display of sunset colours reaching some 120° round the horizon, until, by fifty minutes after sunset, this light has also gone down to a red line of about 2° elevation. I should not have omitted to say that the green light passes to yellow.

By this time night has fairly well come in the eastern half of the heavens, but already another but more delicate silvery whitening begins to show itself on the western curtain, and this also diffuses very rapidly up to the zenith and round to north and south. It also then goes through a process of contracting, intensifying to considerable brightness, and gradually passing through the sunset colours. Night is now full—with or without moonlight, according to date—and from the west, or rather from a point well to the north of it, spreads a delicate but brilliant light, having an almost perfect resemblance to the burning of a vast distant city. The last crimson light of this reflection does not disappear till an hour and a half after sunset.

The phenomena I have attempted to describe cannot possibly, I think, be explained otherwise than as being the effects of reflection, and that from a canopy many miles above the earth's surface. The matter of this canopy is highly transparent, for not only are moon and stars brilliantly clear, but in the crescent moon the dark surface of its sphere was on some nights in both months visible and so distinct as to have been noticed independently by several persons. (It has been suggested that this greater visibility of the dark surface of the moon may be due to a stronger reflection from the present atmosphere of the earth.) The reflecting matter must, I suppose be water, but in what form and under what conditions it is there so high up day after day in varying weather, it is difficult to me to conceive. We have had wet days intervening, cloudy days, and very windy days, but on all occasions, except during rain, the phenomena have been visible with strange uniformity.

Not counting the setting of the silvery glare twenty minutes after sunset, which ought perhaps to be done, there are, it will be seen, two reflected sunsets following the true one. In the morning before sunrise the same phenomena in inverse order are perhaps still more remarkable to see. Indeed the whole phenomena, night and morning, have a most unnatural and magical appearance, very different from those of the ordinary sunset and sunrise.

One other phenomenon, also of reflection, has yet to be mentioned. Rarely with much distinctness, but always to be noticed, there appears high up in the east, just after the silvery glare following the sun has set, and lasting only a few minutes, a dim image of the white glare and the western horizon just after sunset. It is of a delicate rosy light, with a grayish central part.

I am informed that somewhat similar appearances are being seen in Shan hai.

EDWARD DIVERS

Imperial Japanese College of Engineering, Tokio,
December 12, 1883

IF the red sunsets are to be attributed to smoke and dust in the atmosphere from volcanic eruptions, as seems likely from the contributions in the last number of NATURE at hand (December 20), then it becomes important to take into account other eruptions which may have happened simultaneously with or since that of Krakatoa on August 27, 1883. In any discussion of atmospheric currents as fixing the dates of the appearance of these sunset phenomena at different places this is of special importance, in order that no confusion may arise in trying to reconcile places and dates that may refer to dust and ashes brought from entirely distinct eruptions. For this reason I send you the following extracts.

The first is from the U.S. Signal Service *Monthly Weather Review* for October, 1883, and is as follows:—

"Unalaska, Alaska, October 22, 1883

"Executive Officer, Signal Service, U.S.A., Washington, D.C.

"SIR,—I forward by this mail a sample bottle of sand that fell during the storm of October 20, 1883.

"At 2.30 p.m. the air became suddenly darkened like night, and soon after a shower of mixed sand and water fell for about ten minutes, covering the ground with a thin layer. The windows were so covered that it was impossible to see through them.

"This sand is supposed to have come either from the Menkushin or the new volcano adjacent to Bogoslov. The former is at a distance of about nineteen miles south-west, but for years has only issued forth smoke or steam. The latter is a new one, which made its appearance this summer, and burst out from the bottom of Behring Sea. It has been exceedingly active, as it has already formed an island from 800 to 1200 feet high.

"According to the report of Capt. Anderson, the discoverer, who sails one of the company's vessels, and who went within 2000 yards of it, it presents a most magnificent sight. The fire, smoke, and lava are coming out at many crevices, even under the water line. Large boulders are shot high in the air, which, striking the water, send forth steam and a hissing sound.

"Bogoslov is about sixty miles from here, in a westerly direction. The new volcano is about one-eighth of a mile north-west of it.

"I am, Sir, very respectfully,

"S. APPLEGATE,

"Sergt. Sig. Corps, U.S.A."

The other extract is from a recent paper as follows:—

"San Francisco, Cal., December 28, 1883

"Prof. Davidson received from Alaska to-day the particulars of the volcanic disturbances there in October last, near the entrance to Cook's Inlet. On the morning of October 6 a settlement of fishermen on English Bay heard a heavy report, and, looking in the direction from whence the sound came, immense volumes of smoke and flame were seen to burst forth from the summit of Mount Augustine. The sky became obscured, and a few hours later great quantities of pumice dust began to fall, some of it being fine and smooth, and some gritty. At half-past three o'clock on the same day an earthquake wave thirty feet high came rushing in over the hamlet, sweeping away all the boats and deluging the houses. The tide at the time being low saved the settlement from utter destruction. This wave was followed by two other waves eighteen feet high, which were succeeded at irregular intervals by others. The pumice ashes fell to a depth of five inches, making the day so dark that lamps had to be lit. At night the surrounding country was illuminated by flames from the crater. Ordinarily Mount Augustine is covered with snow, but this year it is completely bare. Upon examination after the disturbances had subsided, it was found that the mountain had been split in two from base to summit, and that the northern slope had fallen to the level of the surrounding cliffs. Simultaneously with the eruption, a new island made its appearance in the passage between Chernaboura Island and the mainland. It was seventy-five feet high, and a mile and a half long. So violent was the volcanic action that two extinct volcanoes of the Peninsula of Alaska, lying to the westward of the active volcano Iliamna, 12,000 feet high, burst into activity, and emitted immense quantities of smoke and dust. Flames were visible at night. It is stated that the wives of a party of Aleut Indians, who were engaged in otter-hunting in that locality, became afraid of the subterranean noises, and refused to stay, returning to their homes. None of those who remained can be found."

The approximate positions of some of the points mentioned in these reports are as follows:—

	Lat.	Long.
Iliamna...	60° 1' N.	153° 1' W.
Mount Augustine...	59° 5' N.	153° 5' W.
Unalaska ...	53° 9' N.	166° 5' W.
Bogoslov ...	54° 0' N.	168° 0' W.

Here we have the record of (1) a new volcano which appeared near Bogoslov some time during the summer, and had been continuously active and thrown up an island 1000 feet high up to some time in October; (2) an explosive eruption of Mount Augustine on October 6, which split off the whole side of the volcano and distributed ashes to a depth of five inches many miles away, and started a wave in the ocean about thirty feet high; and (3) of a shower of sand and water on October 20 at Unalaska, which probably arose from some fresh or renewed eruption of a neighbouring volcano.

Many of these phenomena resemble those reported from Krakatoa, though on a smaller scale. It is not necessary to point out that a continuous eruption of a new volcano for weeks

or months would probably eject as much or more dust and ashes than accompanied the Krakatoa convulsion, though not to so great a height. If, however, Mr. Preece's theory of electric repulsion of the dust particles be true, then the finest of them, if highly electrified, might rise to great heights, independent of the force of ejection from the volcano.

In this connection it is well to remember that there may have been many other volcanic outbursts during the last few months, of which we have not yet heard, and perhaps never may. The whole chain of islands from Java to Alaska, including the Philippines and Japan, is full of volcanoes, and seems to be a sensitive seam in the earth's crust. A convulsion like that of Krakatoa is likely to be accompanied or followed by others along this line, the northern portion of which is only visited by otter-hunters.

Without presuming to question the theory as to the rapid transmission of Krakatoa dust by the upper currents of the atmosphere until we see the evidence on which it rests, it occurred to me that the above considerations might possibly modify or supplement it in some degree.

Referring to the remarkable results deduced by General Strachey, showing an atmospheric wave travelling three times round the globe from the Krakatoa eruption, which seems to be of even more scientific interest from a physical point of view than the transmission of the dust and ashes, and which deserves a thorough and careful re-examination when the data are in from all available barometric records, I would say that I have been kindly allowed to examine the barometric records of the Signal Office here at Washington, and I find no trace of any such disturbance following the reported Alaskan eruptions of October 6 and October 20. In connection with the record of the waves following the Krakatoa catastrophe there are some interesting points which I wish to examine more carefully before discussing them.

H. M. PAUL

Washington, January 8

REFERRING to Mr. Burder's letter in NATURE of January 10 (p. 251), is it so certain that, if there be no resisting medium in interplanetary space, the whole of the earth's atmosphere must "rotate with the earth as if it were part and parcel of it"? Take a stratum of the atmosphere at, say, forty five miles in altitude at the equator. According to the received theory, this ought of course to move with a velocity greater than that of the surface of the earth immediately below. But each successive inferior stratum moves with less velocity. And thus they must tend to retard the superior strata with which they may be assumed to be in contact. Of course the merging of stratum into stratum is gradual, but this does not affect the amount of friction and retardation.

In like manner, imagine a section of the atmosphere taken along the equator. Sections taken along successive parallels of declination north and south would tend to retard the velocity of this central layer.

These two causes combined might have a considerable effect in retarding the velocity of the upper atmosphere in equatorial regions. And it seems to me doubtful whether the upper atmosphere near the poles would be actually carried round with each terrestrial rotation. The rarity of the upper regions of the atmosphere and the lessened force of gravity would both help towards the result indicated, inasmuch as they would tend to make the atmosphere less rigid.

As I am writing, I venture to make another suggestion. Gilbert White mentions that in the summer of 1783, when, as at present, the atmosphere was filled with dust consequent on volcanic eruptions, and "a peculiar haze or smoky fog prevailed for many weeks in this island and in every part of Europe, and even beyond its limits," "all the time the heat was so intense that butchers' meat could hardly be eaten the day after it was killed, and the flies swarmed so in the lanes and hedges that they rendered the horses half frantic, and riding irksome." May not the present May-like weather be due to a like cause? Sweet violets, primroses, wallflowers, roses, and several other flowers are now blooming in my garden under the Cleveland Hills.

Had the halos round the moon seen here last and the previous night any possible connection with the dust in the atmosphere? I computed the diameter of the inner dirty white to be twice, the dirty orange one and three-quarters, and the outer green three and a quarter times the moon's apparent diameter.

JOHN HAWELL

Ingleby Greenhow Vicarage, Yorks, January 15

I THINK a few notes relating to the recent sunsets may still have an interest for some readers of NATURE. Notwithstanding the length of time these remarkable phenomena have been apparent, the sunsets of January 11 and 12 were as brilliant as regards the *second* after-glow as any that have preceded them, the final glow having lasted on the 12th till 5.55; while the sun set that evening at 4.12.

The pink halo so often seen of late could not be discerned that day though the sky was cloudless; but it has been often visible when clouds partly obscured the sun, or portions of the sky, and could then be recognised between them, separating the blue of the remoter sky from the whitish light surrounding the sun, as a ring-formed glow of a strong pink colour.

These broad pink halos have been less commented on than the splendid sunsets which have invariably succeeded them, but they have been nearly as persistent in their presence. You have had so many accounts of the succession of colours and effects of the two after-glows, that I will not allude further to them here; but as I have retained a record of many remarkable sunsets and sunrises which I observed in Wales in former days (possibly the very same mentioned by Prof. Piazzi Smyth in NATURE, December 13, 1883, p. 149, as observed by him thirty years ago), and as I carefully noted in them the time and hour of the changes in the sky down to that of the complete extinction of the after light, it may interest others than myself to compare displays of that date with those of this winter.

What is worthy of especial interest is the great difference between the periods of prolongation then and now of the illumination of the western sky, showing that the second after-glow of recent sunsets is a phenomenon distinct from and additional to those belonging to normal sunsets.

The following table exhibits the two series of observations made in 1855, 1856, 1857, and in 1883-84 respectively:—

Date	Sunset at	First after-glow or cone of pink light		Second after-glow in 1883-84, which begins as the first after-glow sets
		Appears as sunset colours are fading	Brightest at	
		Sets		
		1st series, 1855-56-57	2nd series, 1883-84	
Nov. 11, 1856	4.13	5.10	about 4.45	5.45
" 12, " "	4.14	4.55	...	5.45
" 23, 1855	...	4.20	...	...
Dec. 7, " "	3.50	4.20	...	...
" 8, " "	...	4.20	...	...
" 10, " "	...	...	...	...
" 11, 1883	...	...	...	...
" 14, " "	...	4.35	4.21	...
" 15, 1856	...	4.30	4.20	...
" 18, " "	3.50	...	...	...
" 19, " "	3.53	4.30	...	5.45
" 24, 1883	4.13	...	...	5.40
Jan. 11, 1884	...	...	...	5.55
" 12, " "	...	...	...	...
" 15, 1857	...	4.55	at about 5.0	...
" 16, " "	...	5.0	" 5.0	...
" 19, " "	...	5.18	" "	...
" 26, " "	...	5.25	" "	...
Feb. 8, " "	5	...	...	...

The colours associated with the actual sunset are quite in accord in both.

The first after-glow, or pink cone or dome of light appearing after the sunset colours have nearly faded, is also similar in both series, but its time of setting has been apparently somewhat prolonged in the recent observations.

It is the 1883-84 series alone, however, that shows the *second* after-glow, and the duration of this strange phenomenon, which I have the advantage of observing over a wide bird's-eye view in North Wiltshire, has extended on evenings when it could be well